

# PATENT SPECIFICATION

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## PROVISIONAL SPECIFICATION.

### Improvements in and relating to Mirrors suitable for Astronomical Telescopes.

We, The Honourable Sir CHARLES  
ALGERNON PARSONS, O.M., K.C.B., of  
Heaton Works, Newcastle-on-Tyne, in the  
County of Northumberland, a British  
subject, and HARRY CASMEY RANDS, of  
200, Kedleston Road, Derby, in the  
County of Derbyshire, a British subject,  
do hereby declare the nature of this  
invention to be as follows:—

The invention relates generally to  
mirrors and is particularly applicable to  
those of large dimensions used for  
astronomical purposes in telescopes,  
cœlostats or the like.

The main object of the invention is to  
provide an improved mirror of the type  
indicated which, especially in respect of  
certain features to be pointed out below,  
shall be an improvement over those at  
present in use.

With such an object:—

The invention consists in a mirror or  
blank therefor of the kind indicated com-  
prising a member or part provided with  
or to be provided with a reflecting surface  
and an openwork or skeleton supporting  
structure associated therewith.

The invention also consists in a mirror  
or blank therefor of the kind indicated  
comprising two or more discs, plane or  
otherwise, similarly arranged and held in  
rigid relation by spacers.

The invention further consists in a  
method of manufacturing a glass or like  
mirror or blank therefor of the kind  
indicated which consists in assembling  
the member or part associated with the  
reflecting surface in relation to one or  
more similarly arranged parts, preferably  
of the same material, maintained in  
position by a series of spacers and raising  
the whole assembly to approximately the  
softening temperature, with or without  
pressure other than that due to gravity,  
so that the parts fuse or weld together.

The invention finally consists in the  
improved mirrors, blanks therefor and  
methods of manufacture hereinafter  
described or indicated.

In carrying the invention into effect as  
applied, for example, to the production of  
silver-on-glass mirrors, advantage is taken  
of the well-known fact that two pieces of

glass in contact will unite by fusion or  
welding with but slight deformation when  
their temperature is raised to the soften-  
ing point or thereabouts.

According to one form applicable to  
the plane mirror of a cœlostat, two equal  
circular plane discs of plate glass, which  
can be manufactured in large sheets and  
of a thickness up to about two inches, are  
arranged parallel to one another and  
spaced apart by means of a number of  
spacers, both discs and spacers being pre-  
ferably cut from the same sheet so that  
all the glass may have the same main  
characteristics, such as co-efficient of  
thermal expansion, heat conductivity,  
softening temperature and so forth. The  
spacers, which are preferably of exactly  
the same length, should be ground and  
polished where they come in contact with  
the discs and distributed as uniformly as  
possible between them, e.g., according to  
one plan, the spacers may be arranged  
radially in a succession of annuli.

The components so assembled are then  
placed upon a flat and massive iron bed-  
plate, the surface of which is preferably  
coated with kaolin to prevent adhesion  
of the glass, and the whole is placed in a  
furnace; the temperature is then gradu-  
ally raised to the softening point of the  
glass or thereabouts, when the pressure at  
the contact surfaces due to gravity causes  
the plates and spacers integrally to unite  
by fusion or welding. When cool the  
whole forms a rigid openwork "blank",  
the upper surface of which can then be  
ground, polished and figured to the  
required degree of accuracy.

When building a parabolic mirror with  
a large radius of curvature, suitable for  
an astronomical telescope, it may be  
desirable to mould both the top and the  
bottom discs, to approximately the same  
desired curvature before the insertion of  
the spacers between them.

If the mirror is of a comparatively  
small size, two circular discs as described  
may be sufficient, but for larger sizes  
three or more discs with interposed spacers  
may be used, the discs being spaced apart  
at equal or unequal distances.

The spacers may be of any suitable

[Price

cross-section and should be distributed so that the pressure on them per unit area is substantially uniform.

In order to effect the necessary fusion or welding, it may be desirable to increase the pressure on the contacting surfaces of the spacers and plates, for example, by clamping or adding weights. Such additional pressure may be employed in order to obtain fusion at a lower temperature and the term "softening temperature" herein employed is intended to cover this or any other case in which glass surfaces can be made to cohere under suitable conditions of temperature and pressure.

Although in general a mirror according to the present invention is preferably built up of plate glass, a particular method of manufacturing such a mirror being described above, nevertheless, the preferably integral openwork skeleton structure may be manufactured of most other kinds of glass or silica or even of other materials and by other processes when desirable.

By virtue of the present invention, many difficulties attendant on the manufacture and use of the usual solid silver-on-glass mirror are overcome. Thus, in the case of large mirrors as at present constructed, in order to obtain the necessary rigidity, the thickness is usually not less than one-sixth of the diameter and great difficulties are experienced, partly due to the limited size of the pots in which the glass is melted, in producing such large masses of glass of good quality and homogeneity.

In addition, their great weight renders them cumbersome to handle not only

during the different manufacturing stages, for example, figuring, silvering and testing, but also involves heavy and expensive mountings for their manipulation when in use. Further, a mirror of solid glass changes its temperature with extreme slowness in response to changes of temperature of the surrounding air and thus leads in some cases to internal strains and distortion.

In contradistinction to such solid mirrors, a mirror according to the present invention having an openwork or skeleton supporting structure is light and rigid while due to the circulation of the air through it, which may be artificially accelerated if desired, the structure as a whole rapidly responds to changes of temperature; in addition with such a structure, it is possible to secure more perfect annealing.

Finally, openwork mirrors according to the present invention may be manufactured of a size that would scarcely be possible with the solid type.

By use of the present invention, therefore, many of the disadvantages of existing mirrors pointed out above are to a large extent overcome.

Although in order to make clear the nature of the invention, particular forms thereof have been described in detail, nevertheless such detailed description is not intended to restrict the broad scope of the invention as set forth in certain of the opening paragraphs of this specification.

Dated this 11th day of January, 1928.  
MARKS & CLERK.

#### COMPLETE SPECIFICATION.

#### Improvements in and relating to Mirrors suitable for Astronomical Telescopes.

We, The Honourable Sir CHARLES ALGERNON PARSONS, O.M., K.C.B., of Heaton Works, Newcastle-on-Tyne, in the County of Northumberland, a British subject, and HARRY CASMEY RANDS, of 206, Kedleston Road, Derby, in the County of Derby, a British subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates generally to mirrors and is particularly applicable to those of large dimensions used for astronomical purposes in telescopes, celostats or the like.

The main object of the invention is to

provide an improved mirror of the type indicated which, especially in respect of certain features to be pointed out below, shall be an improvement over those at present in use.

With such an object:—

The invention consists in a mirror or blank therefor of the kind indicated comprising a member or part provided with or to be provided with a reflecting surface and an openwork or skeleton supporting structure associated therewith.

The invention also consists in a mirror or blank therefor of the kind indicated comprising two or more discs, plane or otherwise, similarly arranged and held in rigid relation by spacers.

The invention further consists in a

method of manufacturing a glass or like mirror or blank therefor of the kind indicated which consists in assembling the member or part associated with the reflecting surface in relation to one or more similarly arranged parts, preferably of the same material, maintained in position by a series of spacers and raising the whole assembly to approximately the softening temperature, with or without pressure other than that due to gravity, so that the parts fuse or weld together.

The invention finally consists in the improved mirrors, blanks therefor and methods of manufacture hereinafter described or indicated.

In carrying the invention into effect as applied, for example, to the production of silver-on-glass mirrors, advantage is taken of the well-known fact that two pieces of glass in contact will unite by fusion or welding with but slight deformation when their temperature is raised to the softening point or thereabouts.

According to one form applicable to the plane mirror of a cœlostæt, and shown in diagrammatic perspective in the accompanying drawing, two equal circular plane discs of plate glass, which can be manufactured in large sheets and of a thickness up to about two inches, are arranged parallel to one another and spaced apart by means of a number of spacers, both discs and spacers being preferably cut from the same sheet so that all the glass may have the same main characteristics, such as co-efficient of thermal expansion, heat conductivity, softening temperature and so forth. The spacers, which are preferably of exactly the same length, should be ground and polished where they come in contact with the discs and distributed as uniformly as possible between them, e.g., according to one plan, the spacers may be arranged radially in a succession of annuli.

In order to prevent possible movement of the spacers, they may be held in position by a template perforated to receive them and supported on the bottom disc by small feet or lugs. Such a template may be made of thin sheet metal which can be subsequently dissolved away by acid or cut out in small pieces.

The components so assembled are placed upon a flat and massive iron bed-plate, the surface of which, and if desired of the template, is preferably coated with kaolin to prevent adhesion to the glass, and the whole is placed in a furnace; the temperature is then gradually raised to the softening point of the glass or thereabouts, when the pressure at the contact surfaces due to gravity causes the plates and spacers integrally to unite by fusion

or welding. When cool the whole forms a rigid openwork "blank", the upper surface of which can then be ground, polished and figured to the required degree of accuracy.

Care should be taken during treatment in the furnace, that no gases come in contact with the glass which will modify its composition and/or prevent the parts welding together. With this object, either an electrically heated furnace may be used or the fuel may be purified; alternatively, the assembled elements may be enclosed in a suitable container in which by means of a fan or otherwise an atmosphere of pure air or other suitable gas is maintained.

When building a parabolic mirror with a large radius of curvature, suitable for an astronomical telescope, it may be desirable to mould both the top and the bottom discs, to approximately the same desired curvature before the insertion of the spacers between them.

If the mirror is of a comparatively small size, two circular discs as described may be sufficient, but for larger sizes three or more discs with interposed spacers may be used, the discs being spaced apart at equal or unequal distances.

The spacers may be of any suitable cross-section and should be distributed so that the pressure on them per unit area is substantially uniform.

In order to effect the necessary fusion or welding, it may be desirable to increase the pressure on the contacting surfaces of the spacers and plates, for example, by clamping or adding weights. Such additional pressure may be employed in order to obtain fusion at a lower temperature and the term "softening temperature" herein employed is intended to cover this or any other case in which glass surfaces can be made to cohere under suitable conditions of temperature and pressure.

Although in general a mirror according to the present invention is preferably built up of plate glass, a particular method of manufacturing such a mirror being described above, nevertheless, the preferably integral openwork skeleton structure may be manufactured of most other kinds of glass or silica or even of other materials and by other processes when desirable.

By virtue of the present invention, many difficulties attendant on the manufacture and use of the usual solid silver-on-glass mirror are overcome.

Thus, in the case of large mirrors as at present constructed, in order to obtain the necessary rigidity, the thickness is usually not less than one-sixth of the diameter and great difficulties are experienced, partly due to the limited size of the pots in which

the glass is melted, in producing such large masses of glass of good quality and homogeneity.

In addition, their great weight renders them cumbersome to handle not only during the different manufacturing stages, for example, figuring, silvering and testing, but also involves heavy and expensive mountings for their manipulation when in use. Further, a mirror of solid glass changes its temperature with extreme slowness in response to changes of temperature of the surrounding air and thus leads in some cases to internal strains and distortion.

In contradistinction to such solid mirrors, a mirror according to the present invention having an openwork or skeleton supporting structure is light and rigid while due to the circulation of the air through it, which may be artificially accelerated if desired, the structure as a whole rapidly responds to changes of temperature; in addition with such a structure, it is possible to secure more perfect annealing.

Finally, openwork mirrors according to the present invention may be manufactured of a size that would scarcely be possible with the solid type.

By use of the present invention, therefore, many of the disadvantages of existing mirrors pointed out above are to a large extent overcome.

Although in order to make clear the nature of the invention, particular forms thereof have been described in detail, nevertheless such detailed description is not intended to restrict the broad scope of the invention as set forth in the Claims appendant hereto.

Having now particularly described and ascertained the nature of our said inven-

tion and in what manner the same is to be performed, we declare that what we claim is:—

1. A mirror or blank therefor of the kind indicated comprising a member or part provided with or to be provided with a reflecting surface and an openwork or skeleton supporting structure associated therewith, substantially as and for the purpose described.

2. A mirror or blank therefor as claimed in Claim 1, comprising two or more discs, plane or otherwise, similarly arranged and held in rigid relation by spacers, substantially as and for the purpose described.

3. A method of manufacturing a glass or like mirror or blank therefor of the kind claimed in Claim 1, which consists in assembling the member or part associated with the reflecting surface in relation to one or more similarly arranged parts, preferably of the same material, maintained in position by a series of spacers and raising the whole assembly to approximately the softening temperature, with or without pressure other than that due to gravity, so that the parts fuse or weld together, substantially as and for the purpose described.

4. A method of manufacturing a glass or like mirror or blank therefor as claimed in Claim 3, in which the spacers are maintained in the correct position by suitable positioning means which is or are subsequently removed, substantially as and for the purpose described.

5. Methods of manufacturing mirrors or blanks therefor and mirrors or blanks therefor so produced, substantially as hereinbefore described with reference to the accompanying drawing.

Dated this 30th day of August, 1928.

MARKS & CLERK.

*[This Drawing is a reproduction of the Original on a reduced scale.]*

